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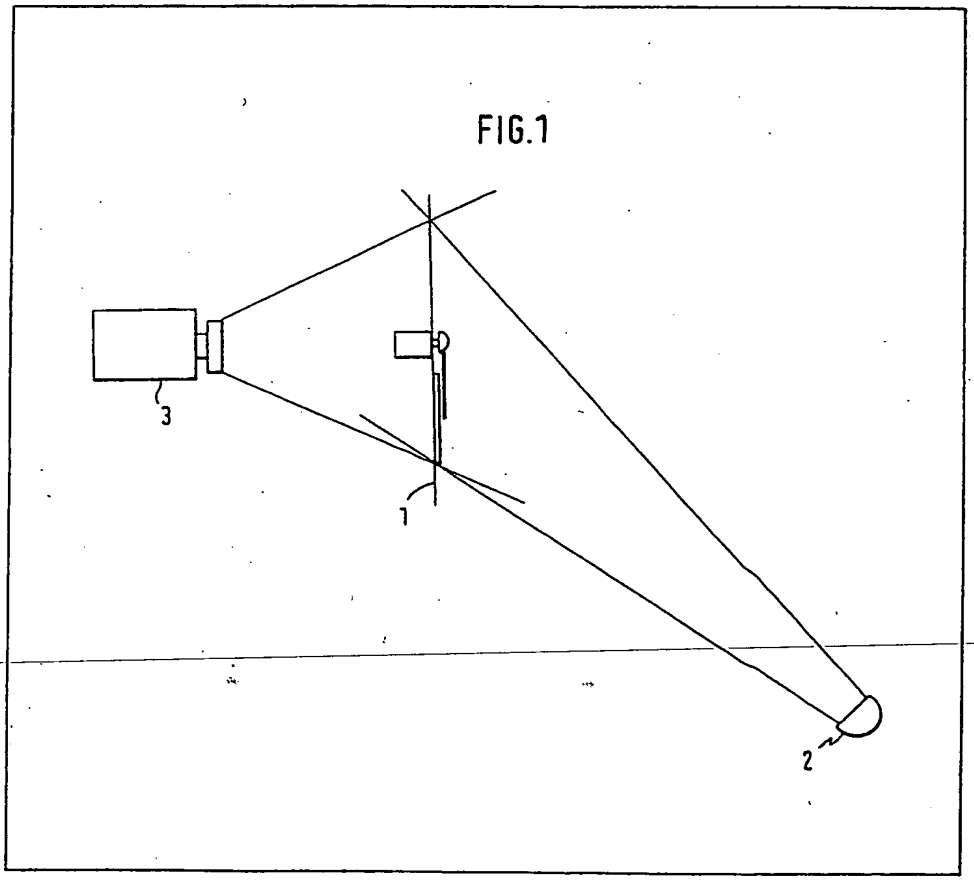
(54) **A method of assessing the quality of a system comprising a wiper blade and the surface of a windscreen**

(57) A method of assessing the quality of a system comprising a wiper blade and the surface of a windscreen (1) by optically observing the diffusion, reflection and diffraction of light by residues of washing fluid remaining in the wiping field during the wiping operation. A light source (2) which is scattered, reflected and diffracted by the said residues is detected by an image sensor (3) and the place and time dependence thus determined are evaluated by analogue and digital electronics for the purpose of assessing the quality of the wiper blade or the quality of the surface of the screen.

FIG.1



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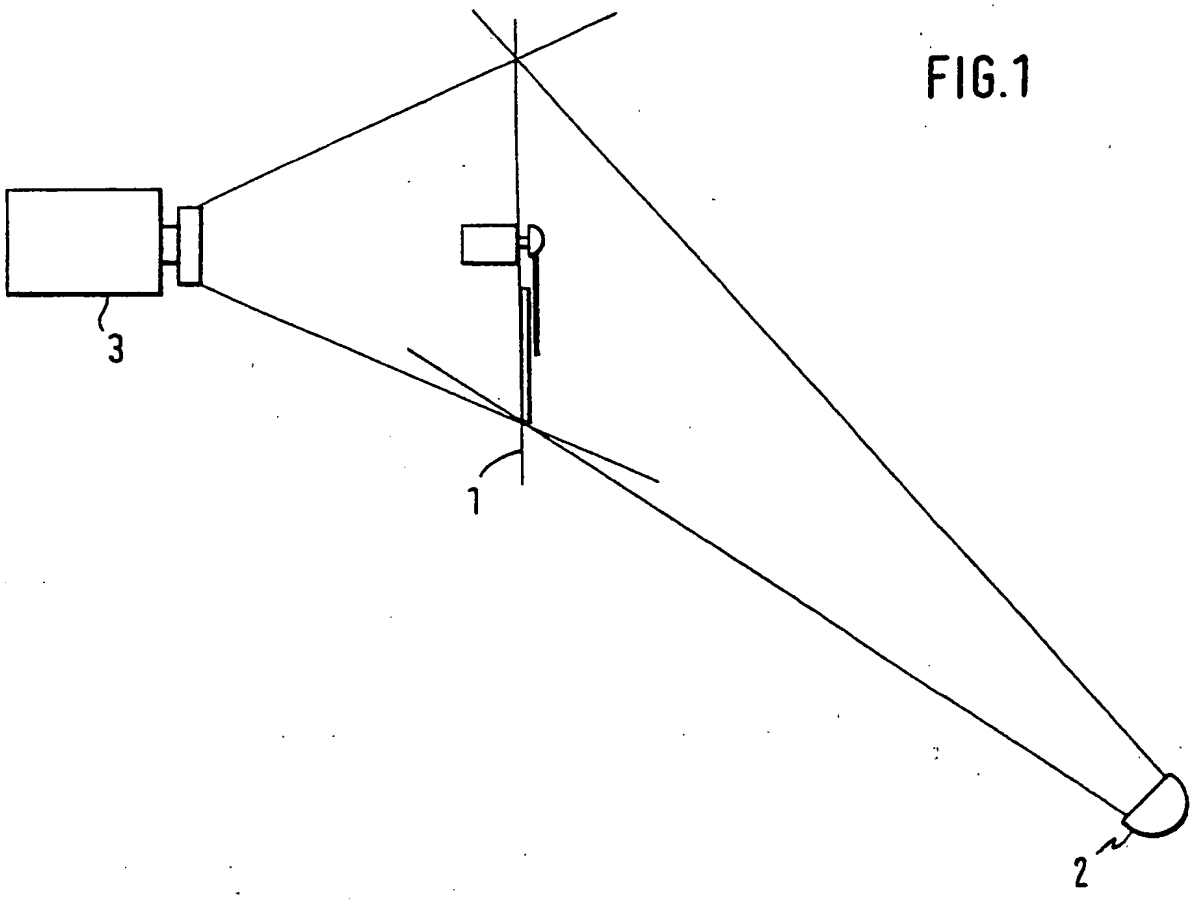
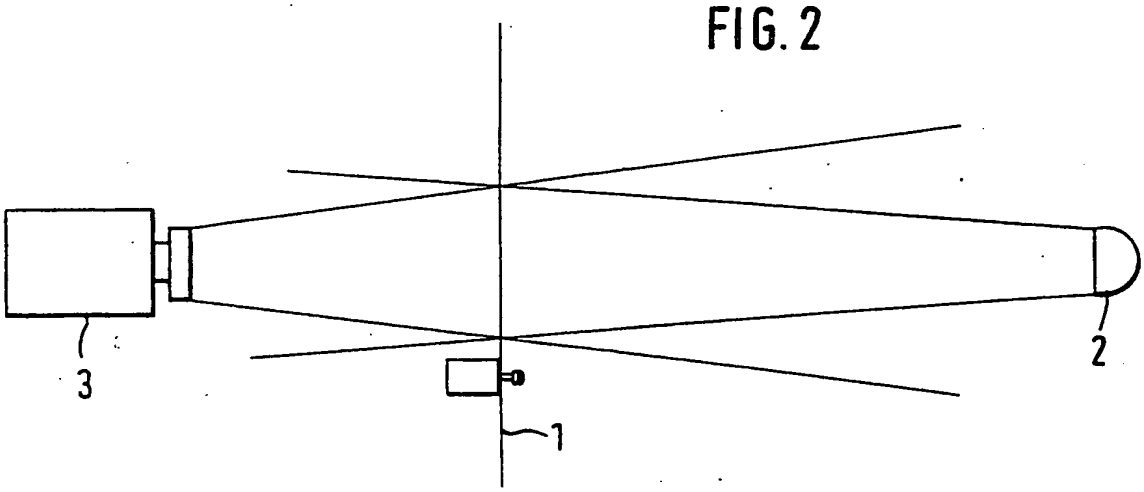


FIG.1

FIG. 2



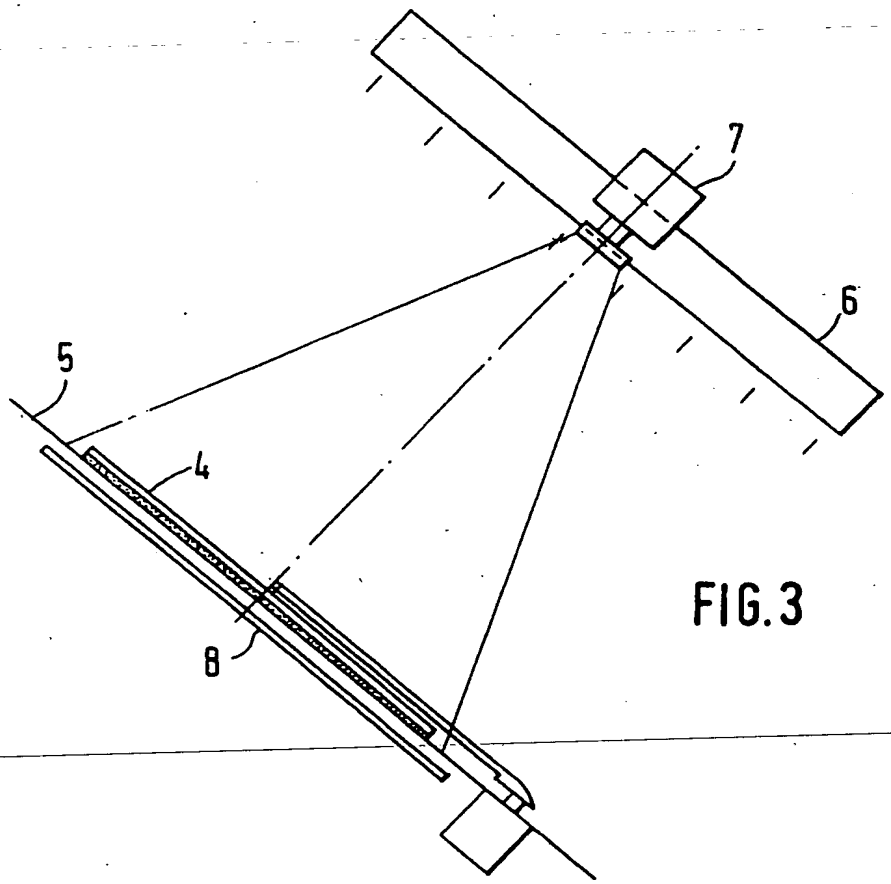


FIG. 3

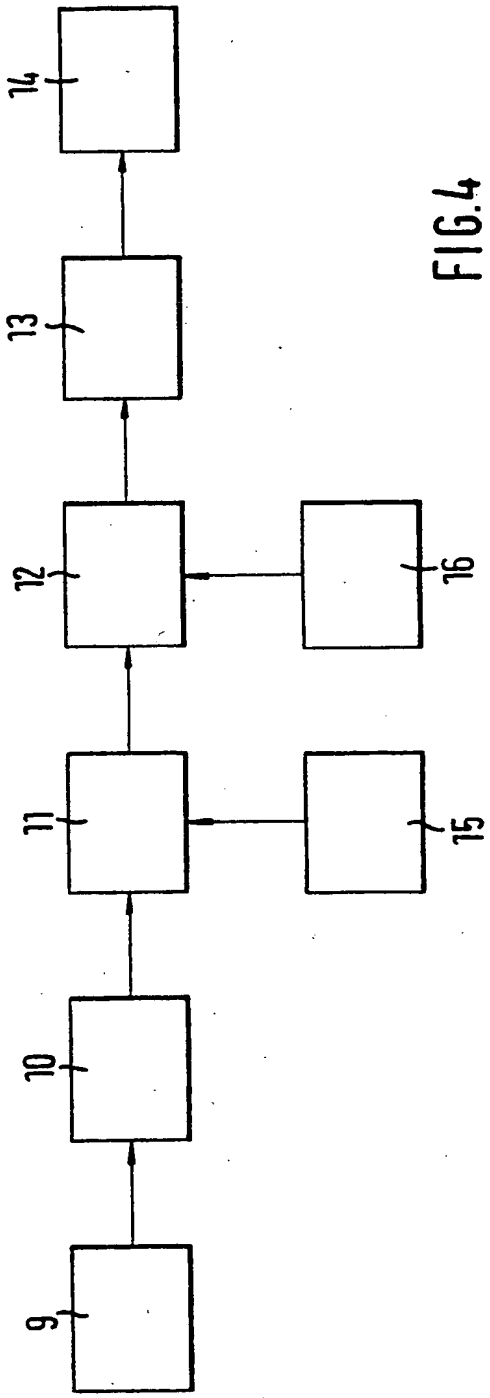


FIG.4

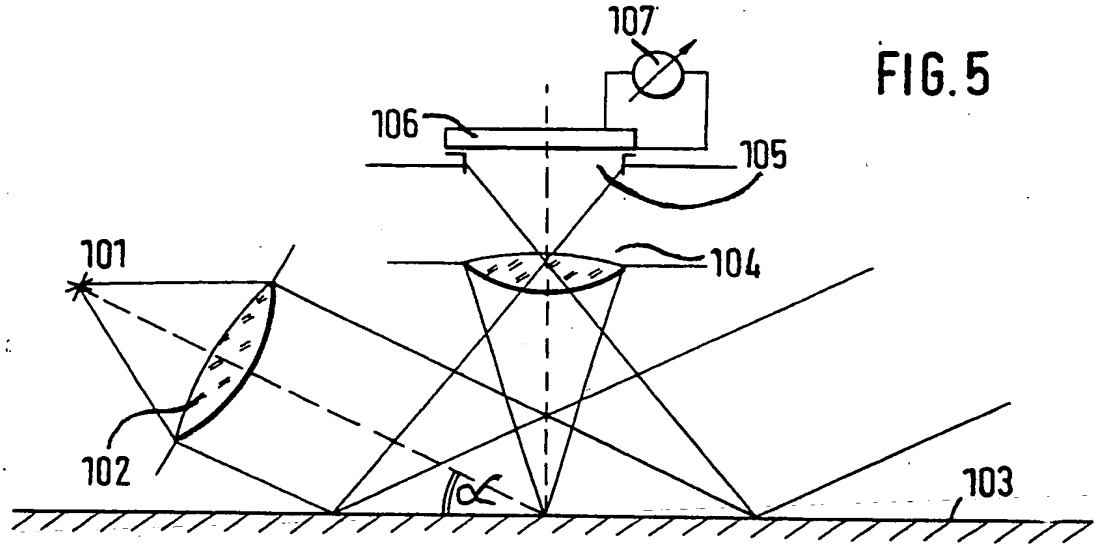


FIG.5

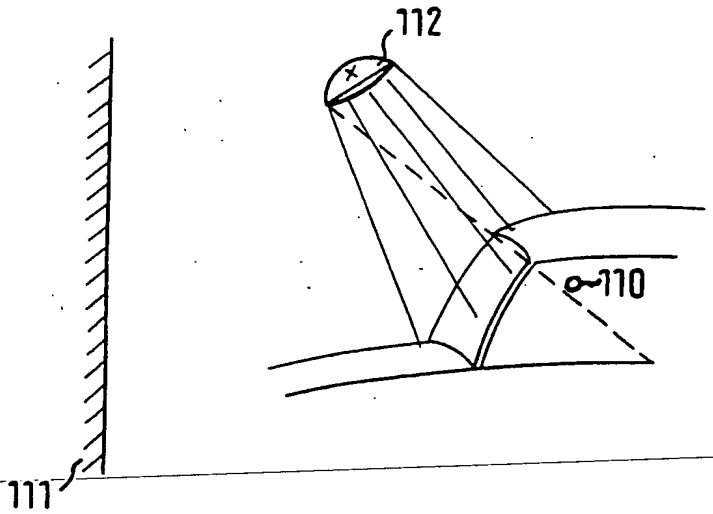


FIG.6

SPECIFICATION

A method of assessing the quality of a system comprising a wiper blade and the surface of a windscreen

The present invention relates to a method of assessing the quality of a system comprising a wiper blade and the surface of a windscreen.

In the field of motor vehicle technology, it is necessary to assess, rationally and objectively, the quality of the system comprising a wiper blade and a windscreen, both in the development phase and in the manufacturing phase and after a long period of operation on the vehicle. In addition to an integral evaluation, data are required with respect to the quality of the wiper blade in part regions of the wiping field and with respect to the surface quality in part regions of the screen, and an evaluation of the residues of water left behind by the wiper and of the scratched and soiled screen with respect to its effect on the driver's perception, taking into account his tasks in traffic. An automatically operating measuring method suitable for this purpose is proposed.

It is known that, with a wiper blade of poor quality, the stray light caused by residues of water, and by scratches and dirt in the case of windscreen surfaces of poor quality, lead to a reduction in the contrast of the visible object to be perceived by the driver. It is thereby difficult or impossible for the driver to perceive low-contrast visible objects.

Travelling by night on a road without permanent lighting and with oncoming traffic proves to be particularly critical. Conditioned by the high intensity of the light of headlamps of approaching vehicles and the weak illumination of visible objects to be perceived by the driver, such as pedestrians, the degree of reduction in contrast and thus effects on the perception are chiefly determined by the light emanating from the headlamps of oncoming vehicles and diffused by the water residues on the hydrophobic screen and by the scratches and dirt on the screen. Thus, it is advantageous to assess the quality of the wiper blade with reference to dependence upon place and time, and to assess the quality of the surface of the screen with reference to the place-dependence of the intensity of the stray light.

Methods of assessing the quality of wiper blades have already been proposed. On the other hand, there are no known methods of assessing the quality of motor vehicle windscreens. Two methods frequently used for assessing the quality of wiper blades are the "grey field method" and the "modified Töpler schlieren method". The "grey field method" uses the differing reflective characteristics of wetted and unwetted glass surfaces and renders visible the regions of the screen covered by water. The tester assesses the quality of the wiper blade with reference to the water residues left in the wiping field by the wiper blade. The "modified Töpler schlieren method" integrally detects the light emanating from an illuminating device and diffused by the water residues left in the wiping field during the wiping operation. For this purpose, the stray light occurring in the wiping field is depicted on a photo-receiver by optical means, and the time-dependent intensity of the light thus measured is evaluated for the purpose of assessing the quality of the wiper blade.

A disadvantage of this method is that, when assessing the quality of the wiper blade, insufficient account is taken of the effect which the water residues, left in the wiping field by the wiper blade, have on the driver's perception. Furthermore, only integral statements on the quality of the wiper blade are made when assessing wipers by means of the "modified Töpler schlieren method".

According to the present invention there is provided a method of assessing the quality of a system comprising a wiper blade and the surface of a windscreen by optically observing the diffusion, reflection and diffraction of light by residues of washing fluid remaining in the wiping field during the wiping operation, in which light which is scattered, reflected and diffracted by residues left in the wiping field by the wiper blade is detected by an image sensor upon illuminating the wiping field or the screen by a source of light, and the place-dependence and time-dependence thus determined, or the place-dependence of the light intensity which is thus determined, are evaluated by analogue and digital electronics for the purpose of assessing the quality of the wiper blade or the quality of the surface of the screen.

A method in accordance with the invention avoids the above-mentioned disadvantages and renders it possible automatically to assess the system comprising the wiper blade and the surface of the screen both in a test installation and also when fitted in the vehicle.

The present invention will now be described further, by way of example only, with reference to the accompanying drawings, in which:—

Fig. 1 is a plan view of the basic measuring assembly;

Fig. 2 is a side view of the measuring assembly of Fig. 1;

Fig. 3 is a side elevation of a second embodiment of a measuring assembly;

Fig. 4 is a block diagram showing the signal-processing stages of a simple evaluation circuit;

Fig. 5 is a diagrammatic view of a suitable optical arrangement; and

Fig. 6 shows an arrangement for qualitative assessment of new and used wiper blades.

Referring now to the drawings, there is shown a system comprising a wiper blade and a screen 1, having a surface to be wiped by the blade, an illuminating device 2 which illuminates the screen 1, and an image sensor 3 which detects the stray light occurring on the screen 1. It is thereby essential that no direct light from the illuminating device should fall onto the photo-sensitive part of the image sensor 3 which is used during the measurements. Thus, information on the place-dependence and time-dependence of the stray

light appearing on the screen 1 is made available by the output signal of the image sensor 3 for the purpose of evaluation. The quality of the wiper blade and the quality of the surface of the screen are then assessed by comparing the measured values with the prescribed values of the intensity of the stray light, or by comparing characteristic quantities derived therefrom, the place-dependence and the time-dependence of the stray light intensity being taken into account for assessing the quality of the wiper blade, and the place-dependence of the stray light intensity being taken into account for assessing the quality of the surface of the screen.

Using this method, it is basically possible to assess the quality of the wiper blade and screen system under a larger number of differing boundary conditions. Boundary conditions are the illumination of the screen and, when assessing the quality of the wiper blade, also the condition of the screen and the composition of the washing fluid. They have to be chosen such that evaluable stray light effects occur. Especially when assessing the quality of the wiper blade, the possibilities extend from a uniformly illuminated hydrophilic screen and a light-diffusing additive of, for example 2 to 20% of latex balls or salt crystals, to the washing fluid, to boundary conditions simulating real traffic situations such as illuminating the screen in the same manner in which it is illuminated when travelling at night with oncoming traffic, and a realistic hydrophobic degree of wetting of the system comprising the washing fluid and the screen. However, to obtain an assessment, taking into account the effect on the driver's perception, realistic boundary conditions are desirable and, for reasons of expense for example, admissible departures from reality have to be taken into account when processing the measured values and when determining the reference values and reference characteristics prescribed for assessing the quality of the wiper blade or the quality of the surface of the screen.

The actual effect of the light scattered on the screen, that is to say, the distribution of the stray light effective on the driver's retina, is ascertained in that, conditioned by its position, the focal length and the size of the diaphragm aperture of its optics and the latter's distance from the photosensitive coating of the image converter, the image sensor depicts the screen out of focus analogously to the driver's eye. Moreover, it is possible to depict the screen in a sharply focused manner and, during the subsequent electronic processing of the measured value, to perform accurately or approximately the optical low pass operation which, in reality, is two-dimensional by virtue of the blurred image in the eye, or by a one-dimensional low pass operation for, for example, assessing the quality of the wiper blade at right angles to the movement of the wiper blade, that is to say, to approximate in a radially symmetrical wiping field along the radii of the wiping field.

The characteristics of the human visual system, the tasks of the driver in actual traffic, and the boundary conditions, departing from reality, in the assessment of the quality of the wiper blade and the quality of the surface of the screen are taken into account when establishing the criteria for comparison with the measured values of the place- and time-dependent or the place-dependent stray light intensity or the characteristic quantities derived therefrom. Thus, for example, when assessing the quality of the wiper blade (and the same applies when assessing the quality of the surface of the screen), the maximum admissible stray light intensity in a region at a predetermined instant after the pass of the wiper blade is established such that the perception capacity does not fall below a limiting value during the assimilation of optical information by this region of the wiping field. By way of example, this limiting value can be given by the requirement that the maximum distance for detecting an obstruction relevant to the traffic, such as a pedestrian, is 50 metres. The maximum detection distance is the distance from which an observer can decide whether a relevant object exists or does not exist.

Furthermore, to compensate for varying boundary conditions, such as fluctuations in the surrounding illumination, changes in the condition of the surface of the screen etc., it is proposed automatically to adapt, before, for example, each series of measurements, the comparison values or characteristic quantities prescribed for assessing the quality of the wiper blade or the quality of the surface of the screen, or the parameters determining the processing of the measured values. It is possible to determine the actual boundary conditions by the control measurements, for example with wiper blades or on screens of known quality or by controlled measurements of some parameters such as the degree of wetting by washing fluid and the surface of the screen, the surrounding illumination etc.

It is desirable to assess the quality of the wiper blade or the quality of the surface of the screen with regard to the wiping performance in the entire wiping field and with regard to the scratches and soiling on the entire surface of the screen, although this is only possible in special cases owing to the necessary expense involved in detecting, by measuring technology, the distribution of the stray light and in detecting and processing the measured values. Therefore, when assessing the quality of the wiper blade or the quality of the screen, it is proposed to confine oneself to that portion of the wiping field or of the screen which is located in the driver's central field of vision and/or, for the purpose of assessing the quality of the wiper blade or the quality of the surface of the screen, to determine and evaluate the place-dependence of the stray light intensity one-dimensionally, for example in a radially symmetrical wiping field along a diameter of the wiping field, in one or a few representative regions of the wiping field or of the screen. Disregarding the addition of light-diffusing substances, or substances which increase the surface tension,

such as wetting agents, to the washing water, and disregarding the use of other washing fluids, a certain disadvantage of the method, proposed above, for assessing the quality of wiper blades resides in the fact that the surface to be wiped must be at least slightly hydrophobic. This can be avoided by changing to a method which uses the differing reflection characteristics of wetted and non-wetted glass surfaces.

The side elevation of Figure 3 shows the principle of the measuring arrangement proposed for this purpose.

The wiper blade 4 to be assessed runs on the test screen 5 which is illuminated by an illuminating device 6 which, for example is flat or which radiates in a diffused manner. An image sensor 7 detects the light reflected from wetted and non-wetted portions of the screen 5. The contrast between the wetted and non-wetted regions is increased by a light-absorbing wall 8 behind the screen or by a light-absorbing coating on the rear wall of the screen. Conditioned by the fact that the reflecting power of the wetted screen is less than that of the dry screen, the water residues remaining in the wiping field appear darker than the dry regions of the screen. The water residues remaining the wiping field can be detected by comparing the distribution of the luminous density, measured during the wiping operation, with the dry screen. The place and the disappearance with respect to time, conditioned by the evaporation effect, of the water residues are evaluated for the purpose of assessing the quality of the wiper blade. By way of example, the areas of the portions of the wiping field which are covered by water residues left behind by the wiper blade are determined at suitable instants during the wiping operation and are evaluated for the purpose of assessment, place-dependent weighting of the individual surface components being advantageous. For reason of expense, it is further proposed to confine oneself to that portion of the wiping field which is located in the driver's central field of vision when assessing the quality of the wiper blade and/or to determine the water residues remaining in the wiping field one-dimensionally, for example in a radially symmetrical wiping field along a diameter of the wiping field, and to evaluate them for the purpose of assessing the quality of the wiper blade.

The processing of the measured values necessary in the proposed method is performed by known methods of analogue and digital technology. Figure 4 shows, by way of example, the signal-processing stages of a simple evaluation circuit for assessing the quality of the cleaning of the screen or of the quality of the wiper blade. The output signal of the image sensor 9 is converted by an analogue-to-digital convert r and, by means of a comparator 11, is compared work-wise with prescribed values. The comparison results are weighted with predet rmined weighting factors by means of a multiplier 12, and the weighted values are added up by an adder 13. The total thus obtained is displayed as a measurement result by a display unit 14. The comparison values and the weighting factors are stored in memories 15, 16.

Cameras having conventional camera tubes, or vidicons or semiconductor transducers or one- and two-dimensional CCD arrays are suitable for use as image sensors. Several image sensors can be used in order to increase the measurement accuracy or to simplify the processing of the measured values.

In a method operating with salt crystals dissolved in the washing fluid, such as 2% to 20% in Na CL or NH_4 CL in distilled water, the salt solution is applied to the screen and is wiped off once with the wiper blade to be tested. Since residual solution remaining on the screen evaporates rapidly, the crystallized-out salts are recorded. This has the following advantages:

The method is independent of the condition of the screen (hydrophilic or hydrophobic), temperature, moisture and air flows.

The salt crystals do not diffuse the light in all directions.

The stray light is an accurate indication, largely free from interference effects, of the quantities of water which have passed through below the wiping lip at the various locations on the screen.

The stray light does not change during observation or measurement.

The stray light of the salts crystals can also be recorded from one side of the windscreen. This simplifies the measuring device.

Figure 5 shows an optical arrangement suitable for this purpose. An incandescent lamp 101 illuminates the intended test area of the windscreen 103 by way of a condenser lens 102 at an angle α of approximately 20 to 30°. The stray light receiver, comprising the lens 104, the field aperture 105, the photo-element 106 and the microammeter 107, is located substantially at right angles to the screen 103. The wiper is actuated after the screen 103 has been sprayed with an aqueous solution of salt. The residual fluid left behind evaporates within a few seconds after a pass by the wiper blade, and the salt crystallizes. The stray light can then be measured immediately. Standard wipers can serve to calibrate the device for measuring the stray light, or a standard diffuser such as a matt grey paper sample may be used.

An arrangement shown in Figure 6 can serve for the qualitative visual comparison of used wiper blades with new wiper blades. The driver looks from point 110 towards a dark wall 111 from his normal seated position in the interior of the vehicle. A headlamp 112 illuminates the windscreen 103 from above, so that precisely the point 110 is not illuminated. The salt which has crystallized out after a wiping operation becomes visible, and used wiper blades can be compared with new ones.

The above-described processing of the measured values can also be subordinated to this method.

CLAIMS

1. A method of assessing the quality of a system comprising a wiper blade and the surface of a windscreen by optically observing the diffusion, reflection and diffraction of light by residues of washing fluid remaining in the wiping field during the wiping operation, in which light which is scattered, reflected and diffracted by residues left in the wiping field by the wiper blade is detected by an image sensor upon illuminating the wiping field or the screen by a source of light, and the place-dependence and time-dependence thus determined, or the place-dependence of the light intensity which is thus determined, are evaluated by analogue and digital electronics for the purpose of assessing the quality of the wiper blade or the quality of the surface of the screen.

2. A method as claimed in claim 1, in which the quality of the wiper blade is assessed by comparing the place- and time-dependent values of the stray light intensity measured during the wiping operation, or characteristic quantities derived therefrom, with predetermined values or characteristic quantities.

3. A method as claimed in claim 1, in which the quality of the surface of the screen is assessed by comparing the measured place-dependent values of the intensity of the stray light, or characteristic quantities derived therefrom, with predetermined values or characteristic quantities.

4. A method as claimed in any of claims 1 to 3, in which evaluable stray light effects are produced by the distribution of the luminous density of the surrounding field, for example by illuminating the screen with a strong source of light in a darkened space.

5. A method as claimed in any of claims 1, 2 or 4, in which evaluable stray light effects are produced by adding 2 to 20% of a light-diffusing substance to the washing fluid, or by changing the surface tensions of the washing fluid and/or the surface of the screen by, for example, surfactants and/or water-repelling agents.

6. A method as claimed in claim 5, in which microscopic latex balls are used as the light-diffusing substance.

7. A method as claimed in claim 5, in which soluble salt crystals are used as the light-diffusing substance.

8. A method as claimed in claim 5, in which insoluble salt crystals are used as the light-diffusing substance.

9. A method as claimed in any of claims 5 to 8, in which the illumination, and the measurement of the stray light, are effected photoelectrically from one side, such as the outside, of the windscreen.

10. A method as claimed in any of claims 5 to 9, in which the stray light emanating from the illuminated screen is assessed from the light-illuminated driver's seat.

11. A method as claimed in claim 1 or 2, in which boundary conditions based on actual traffic situations, such as illumination of the wiping field which occurs when travelling at night with oncoming traffic, and a hydrophobic degree of wetting of the system comprising the washing fluid and the surface of the screen, are created for the purpose of assessing the quality of the wiper blade.

12. A method as claimed in claim 1 or 3, in which boundary conditions based on actual traffic situations, such as illumination of the screen which occurs when travelling at night with oncoming traffic, are created for the purpose of assessing the quality of the screen.

13. A method as claimed in any of claims 1 to 9, in which boundary conditions departing from reality, such as an unrealistically illuminated screen, are taken into account when processing the measured values and when determining the comparison values and/or characteristic quantities prescribed for assessing the quality of the wiper blade or the quality of the surface of the screen.

14. A method as claimed in any of claims 1 to 13, in which by the position, the focal length and the size of the aperture of the diaphragm of its image-forming optics, and the distance thereof from the photo-sensitive coating of its image converter, the image sensor reproduces the wiping field or the screen out of focus, analogously to the eye of the driver of a motor vehicle.

15. A method as claimed in any of claims 1 to 14, in which a measurement of the distribution of the stray light departing from the features of claim 14 is accurately or approximately compensated for during processing of the measured values.

16. A method as claimed in any of claims 1 to 15, in which the values or characteristic quantities prescribed for comparison with the measured place- and time-dependent or place-dependent values of the intensity of the stray light, or characteristic quantities derived therefrom, take into account the characteristics of the human visual system and the tasks of the driver in actual traffic.

17. A method as claimed in any of claims 1 to 16, in which the prescribed comparison values, characteristic quantities or the parameters, determining the processing of the measured values, of boundary conditions which themselves vary, are automatically adapted, for example before every series of measurements, and that the determination of the actual boundary conditions necessary for this purpose is performed by control measurements such as with wiper blades or on screens of known quality or by controlled measurements of individual parameters such as the degree of wetting of the washing fluid and surface of the screen, the illumination of the surrounding field etc.

18. A method as claimed in any of claim 1 to 17, in which the assessment of the quality of the wiper blade or of the quality of the surface of the screen is confined to that portion of the wiping field or of the screen which is located in the central field of vision of the driver.

19. A method as claimed in any of claims 1 to 18, in which the place-dependent of the intensity of the stray light is determined one-dimensionally, for example in a radially symmetrical wiping field

along a diameter of the wiping field, in some or a few representative regions of the wiping field or of the screen.

20. A method as claimed in claim 1, in which the residues of the washing fluid remaining in the wiping field are detected by comparing the distribution of the luminous density measured in reflection during the wiping operation with that of the dry screen, and that the place and/or the disappearance with respect to time of the residues of the washing liquid, conditioned by the effects of evaporation, are evaluated for the purpose of assessing the wiping quality.

21. A method as claimed in claim 1 or 20, in which the assessment of the quality of the wiper blade is confined to the central region of the wiping field.

22. A method as claimed in claims 1, 20 or 21, in which for the purpose of assessing the quality of the wiper blade, the residues left in the wiping field are determined and evaluated one-dimensionally, for example in a radially symmetrical wiping field along a diameter of the wiping field, in one or a few representative regions of the wiping field.

23. A method as claimed in any of claims 1 to 22, in which a camera having a conventional camera tube, such as a Vidicon, or having a semiconductor transducer, such as a CCD array, is used as the image sensor.

24. A method as claimed in any of claims 1 to 23, in which the place- and time-dependent or the place-dependent light intensity is detected by several image sensors.

25. A method of assessing the quality of a system comprising a wiper blade and the surface of a windscreen substantially as hereinbefore described with reference to the accompanying drawings.

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